



# Process-level Power Estimation in VM-based Systems

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## ► To cite this version:

Maxime Colmant, Mascha Kurpicz, Pascal Felber, Loïc Huertas, Romain Rouvoy, et al.. Process-level Power Estimation in VM-based Systems. European Conference on Computer Systems (EuroSys) - Poster session, Apr 2015, Bordeaux, France. hal-01132495

**HAL Id: hal-01132495**

**<https://inria.hal.science/hal-01132495>**

Submitted on 20 Apr 2015

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# Process-level Power Estimation in VM-based Systems

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Research session 5: Virtualization, 23 April, 10:50 am.

## Motivation

### Problem

- Massive power consumption by data centers
- Hard to identify the largest power consumers
- Cannot attach a power meter to a VM
- Current approaches not fine-grained enough

### Vision

- Process-level power estimation in VM-based systems
- Support for all CPU features
- Support for multi-tenant virtualization

## Metrics

### Hardware (HW) Performance Counters

- Representative and accurate metrics
- Mostly available on modern processors

### Criteria selection

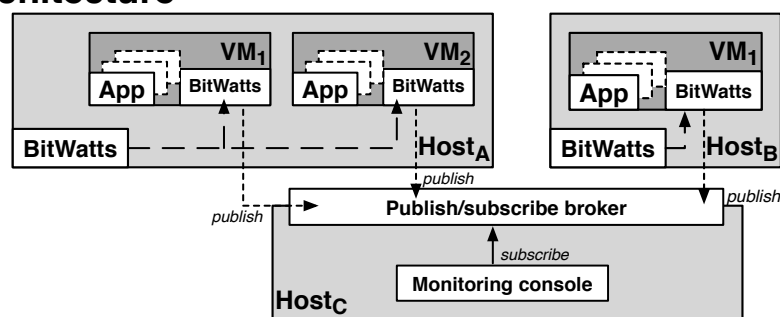
- Counter availability per CPU
- Monitoring overhead
- Best fit under several workloads

### Selected HW Performance Counters

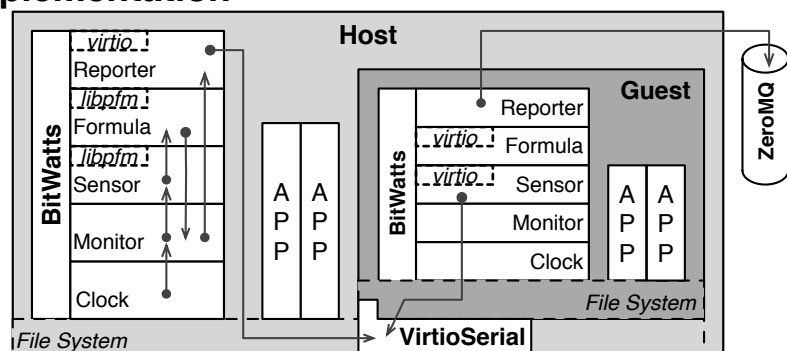
- CPU\_CLK\_UNHALTED:THREAD\_P ( $uc$ )
- CPU\_CLK\_UNHALTED:REF\_P

## BitWatts

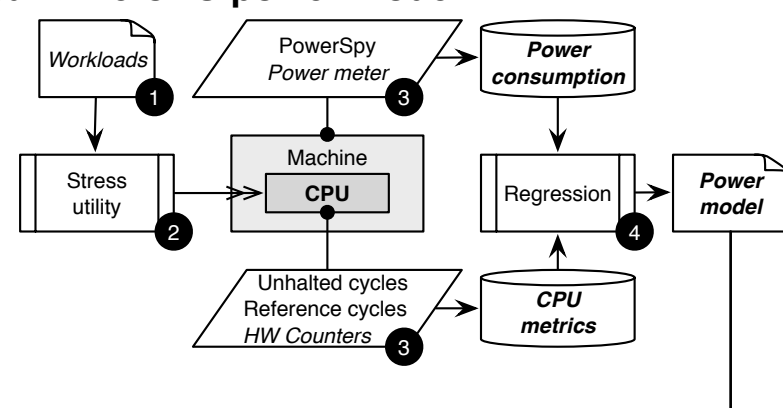
### Architecture



### Implementation



### Learn the CPU power model

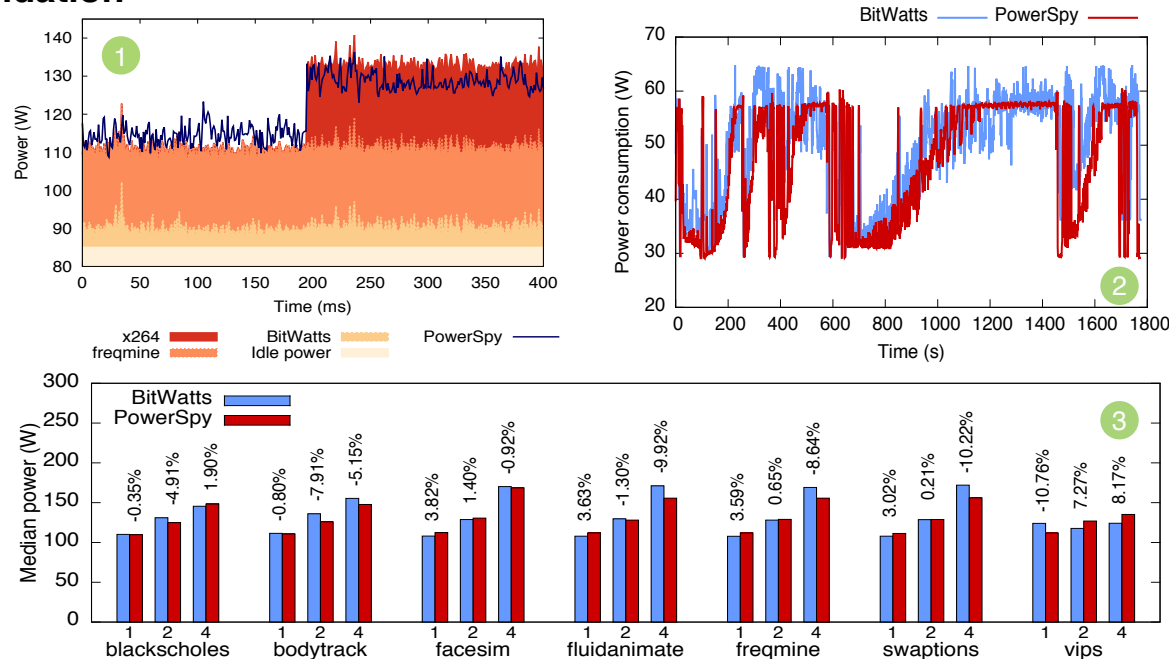


### Power Model

$$P_{host}(f) = P_{idle}(f) + \sum_{pid \in PIDs} P_{cpu}(f, uc_{pid}^1 \dots uc_{pid}^N)$$

$$P_{cpu}(f, uc_{pid}^1 \dots uc_{pid}^N) = \sum_{n=1}^N P_f(uc_{pid}^n)$$

### Validation



- 1 Process-level power consumption of BitWatts, x264, and freqmine on a Xeon W3520 processor
- 2 Power consumption during the execution of SPECjbb on a i3 2120 with two threads
- 3 Power consumption of the host when scaling PARSEC on multiple VMs

